gov. 00-583

Functional Design Report

The other copy
Kept on This #
is more complete.

Reconstruction of MERRIMAC STREET, CAUSEWAY STREET, LOMASNEY WAY, MARTHA ROAD and J.F.F. EXPRESSWAY SURFACE ROAD

Prepared for

The Boston Redevelopmen Authority

Incomplete ?

p. V-28 missing, There also

September 1984

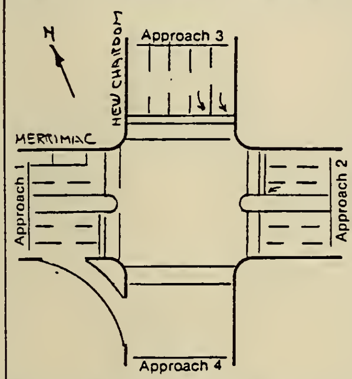
THE MAGUIRE GROUP
CE MAGUIRE, INC.
Architects . Engineers . Planners
60 First Avenue, Waltham, Massachusetts 02254

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection MERRIMAC ST. AT NEW CHARDON ST. **Design Hour** 1987 PM PH

Problem Statement FIND 1987 LOS

Step 1. Identify Lane Geometry



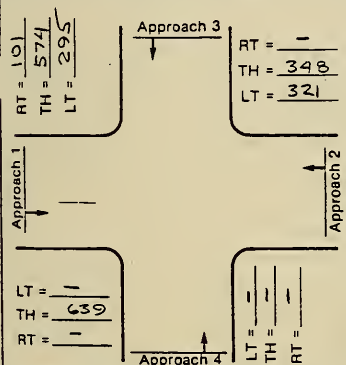
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

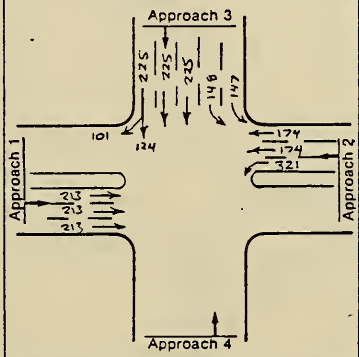
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

213 + 225 + 321 + ____

= 759 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

A

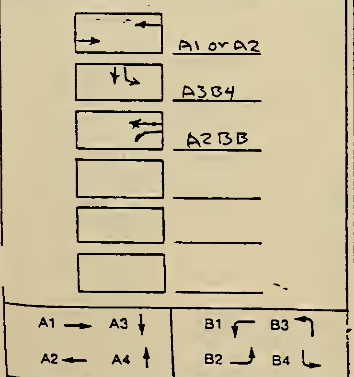
Step 9. Recalculate

Geometric Change ____

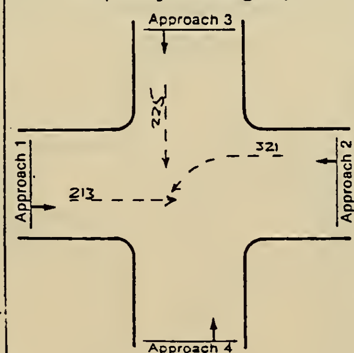
Signal Change ____

Volume Change ____

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



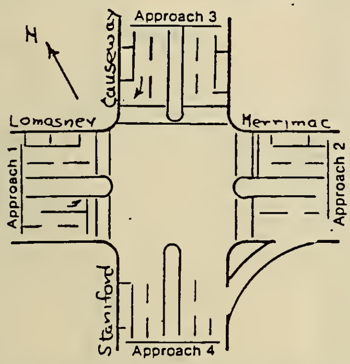
Comments

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection LOMASNEY WAY AT CAUSEWAY ST. HERRIMAC ST & STANIFORD ST. Design Hour 1987 PM PH

Problem Statement FIND 1987 LOS FOR ALTERNATE "A"

Step 1. Identify Lane Geometry



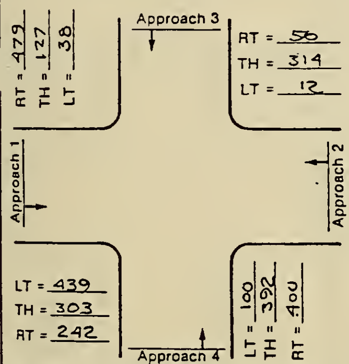
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour		40	40	40
b. Left turn capacity on change interval, in vph		80	80	80
c. G/C Ratio		.25	.25	.40
d. Opposing volume in vph		228	557	364
e. Left turn capacity on green, in vph		72	0	116
f. Left turn capacity in vph (b + e)		152	80	196
g. Left turn volume in vph		12	38	100
h. Is volume > capacity (g > f)?		ok	ok	ok

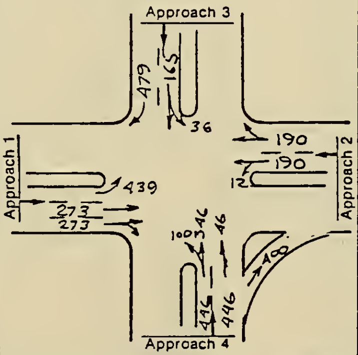
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
A4 B3	200 (A4 B3)	446-200=246	200
A4 B3 or A3 B4	246 38 (B4)	0 479-246 = 233 (A3)	246 38
Ped B2	140 ①	0	140
A1 B2 or A3	439-140=299 233 (A3) 273-439 (A1)	0 0 0	299
A1 or A2B1	0 190	0 0	190

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

200 + 246 / 38 + 140 / 299 + 190

= 1113 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

D

Step 9. Recalculate

Geometric Change ________

Signal Change ________

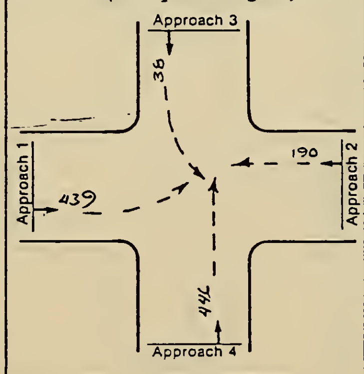
Volume Change ________

Step 3. Identify Phasing

G/C	Phase
.15	A4B3
.25	A4B3 or A3B4
.35	A1B2 or A3
.25	A1 or A2B1

A1 → A3 ↓ B1 B3
A2 ← A4 ↑ B2 B4

Step 6a. Critical Volumes, in vph (two phase signal)



Comments

① vehicle equivalent of an 18second pedestrian movement timed every other cycle.

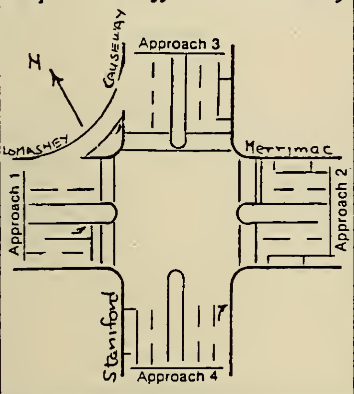
Critical Movement Analysis: PLANNING

Calculation Form 1

Intersection LOMASNEY WAY AT CAUSEWAY ST. MERRIMAC ST & STANIFORD ST. **Design Hour** 1987 PM PH

Problem Statement FIND 1987 LOS FOR ALTERNATE "B"

Step 1. Identify Lane Geometry



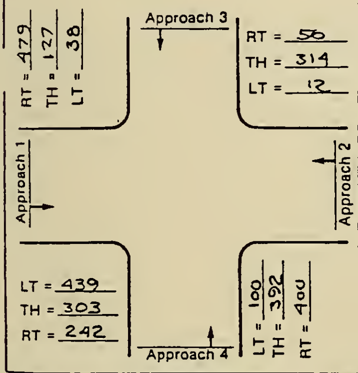
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour		40	40	40
b. Left turn capacity on change interval, in vph		80	80	80
c. G/C Ratio		.25	.25	.40
d. Opposing volume in vph		228	557	364
e. Left turn capacity on green, in vph		72	0	116
f. Left turn capacity in vph (b + e)		152	80	196
g. Left turn volume in vph		12	38	100
h. Is volume > capacity (g > f)?		ok	ok	ok

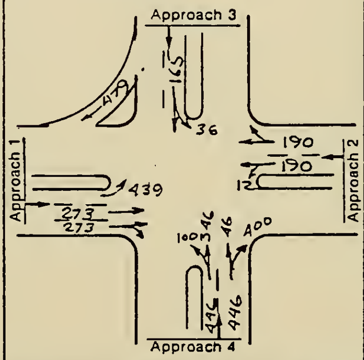
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
A4B3	200 (A4B3)	446-200=246	200
A4B3	246	0	246
or A3B4	38 (B4)	479-246=233 (A3)	38
Ped B2	140 ①	0	140
A1B2	439-140=299 (B2)	0	
or	233 (A3)	0	299
A3	273-439 (A1)	0	
A1	0	0	
or A2B1	190	0	190

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

200 + 246 / 38 + 140 / 299 + 190

= 1113 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

D

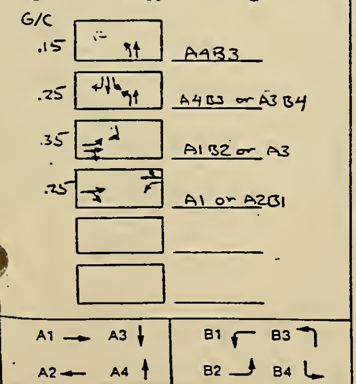
Step 9. Recalculate

Geometric Change ______

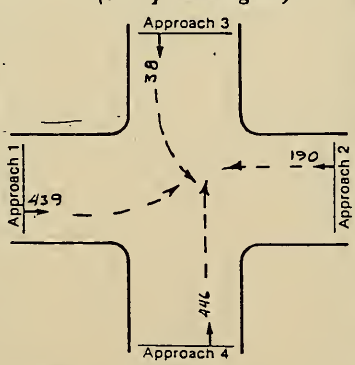
Signal Change ______

Volume Change ______

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



Comments

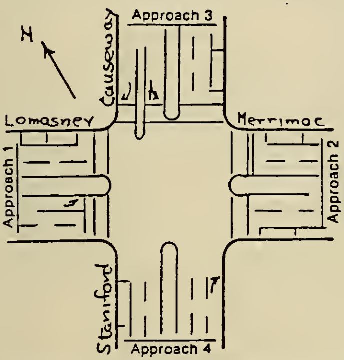
① Vehicle equivalent of an 18 second pedestrian movement timed every other cycle.

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection LOMASNEY WAY AT CAUSEWAY ST. / HERRIMAC ST & STANIFORD ST. **Design Hour** 1987 PM PH

Problem Statement FIND 1987 LOS FOR ALTERNATE "C" & "D."

Step 1. Identify Lane Geometry



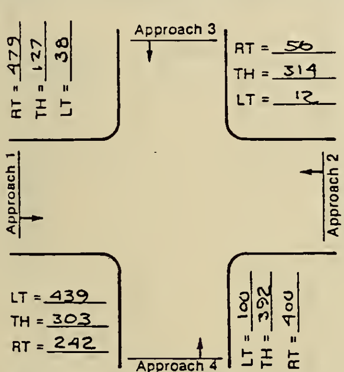
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour		40	40	40
b. Left turn capacity on change interval, in vph		80	80	80
c. G/C Ratio		.25	.25	.40
d. Opposing volume in vph		228	557	364
e. Left turn capacity on green, in vph		72	0	116
f. Left turn capacity in vph (b + e)		152	80	196
g. Left turn volume in vph		12	38	100
h. Is volume > capacity (g > f)?		ok	ok	ok

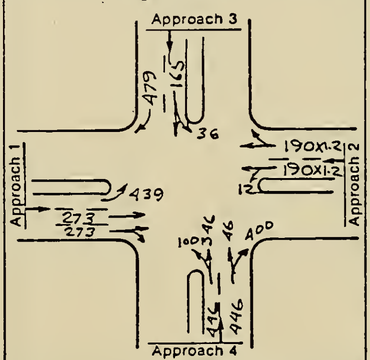
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
A4 B3	200 (A4 B3)	446-200=246	200
A4 B3 or A3 B4	246 38 (B4)	0 479-246 = 233 (A3)	246 38
All Red Clear ①	60.		60
Ped B2	140 ②	0	140
A1 B2 or A3	439-140=299 233 (A3) 273-439 (A1)	0 0 0	299
A1 or A2 B1	0 190	0 0	190

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

200 + 246 / 38 + 140 / 299 + (190x1.2) ③

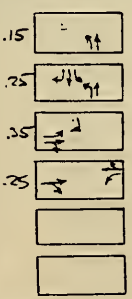
= 1211 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

D

Step 3. Identify Phasing



.15 A4B3

.25 A4 B3 or A3 B4

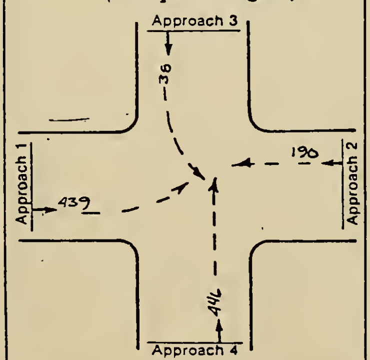
.35 A1 B2 or A3

.25 A1 or A2B1

A1 → A3 ↓ B1 B3

A2 ← A4 ↑ B2 B4

Step 6a. Critical Volumes, in vph (two phase signal)



Step 9. Recalculate

Geometric Change ______

Signal Change ______

Volume Change ______

Comments

① 3 second all red results in a loss of lane volume of 1½ vehicles per cycle for 40 cycles = 60

② Vehicle equivalent of an 18 second pedestrian movement timed every other cycle

③ Traffic volume increased by a factor of 1.2 to cover delay caused by dog leg movement.

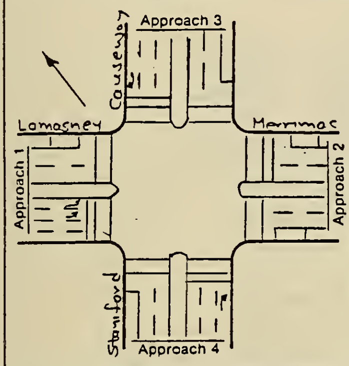
Critical Movement Analysis: PLANNING
Calculation Form 1

LOMASNEY WAY AT CAUSEWAY ST.,

Intersection MERRIMAC ST & STANIFORD ST **Design Hour** 2000 PM PH

Problem Statement Find 2000 LOS ALTERNATE "C" & "D"

Step 1. Identify Lane Geometry



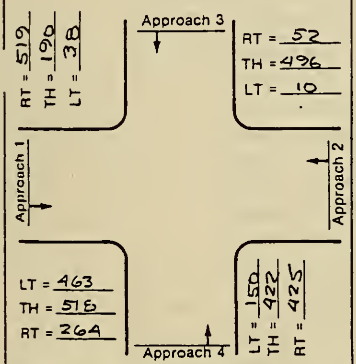
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour		40	40	40
b. Left turn capacity on change interval, in vph		80	80	80
c. G/C Ratio		35	30	45
d. Opposing volume in vph		497	664	435
e. Left turn capacity on green, in vph		0	0	105
f. Left turn capacity in vph (b + e)		80	80	185
g. Left turn volume in vph		10	38	150
h. Is volume > capacity (g > f)?		ok	ok	ok

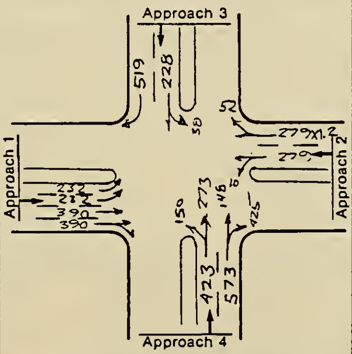
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
A4 B3	200 (A4 B3)	573-200 373	200
A4 B3 or A3 B4	373 38 (B4)	519-373 =146 (A3)	373 38
All Red ①	60	0	60
Ped B2	140 ③ - 0	0 332-140 =192 (B2)	140
A1 B2 or A3	92 146	390-146 = 244 (A1)	146
A1 or A2 B1	244 279	0 0	279

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

$$200 + \begin{matrix}373\\-38\\60\end{matrix} + \begin{matrix}140\\146\end{matrix} + (279 \times 1.2)^{②}$$

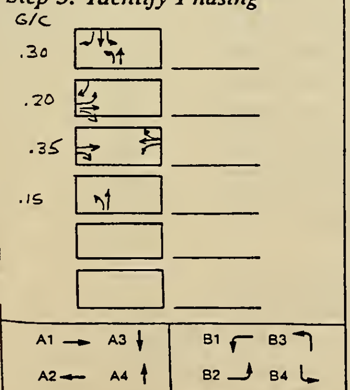
= 1291 vph

Step 8. Intersection Level of Service

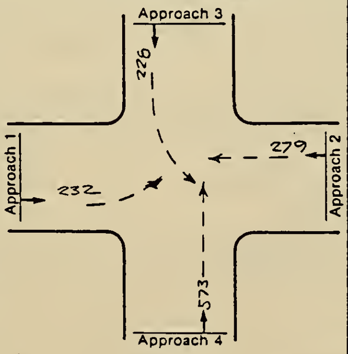
(compare Step 7 with Table 6)

E

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



Step 9. Recalculate

Geometric Change ____________

Signal Change ____________

Volume Change ____________

Comments

① 3 second all-red clearance interval results in a loss of lane volume of 1½ vehicles per cycle for 40 cycles = 60

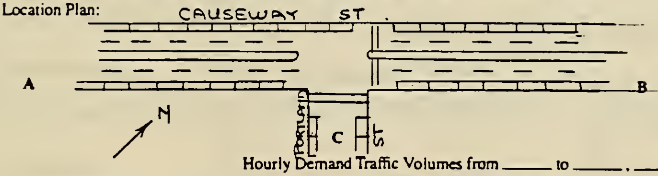
② Critical volume increased by a factor of 1.2 to cover delay caused by dog leg movement

③ Vehicle equivalent of an 18 second pedestrian movement timed every other cycle

Unsignalized "T" Intersection Capacity Calculation Form

Intersection CAUSEWAY ST AT PORTLAND ST.

Location Plan:



Hourly Demand Traffic Volumes from ______ to ______, ______ m

Counts:
Date 1987
Day WEEKDAY
Time PM PEAK HOUR
Control STOP SIGN
Prevailing Speed 30 MPH

Approach	A		B		C	
Movement	A_T	A_R	B_L	B_T	C_L	C_R
Volume	887	0	0	664	24	43
pch (see Table 1)			0		26	47

Step 1	**Right Turn from C**	C_R
	Conflicting Flows = M_H = (from Fig. 1)	$\frac{1}{2}A_R + A_T =$ 0 + 887 = 887 vph
	Critical Gap from Table 2 T_g =	7.0 sec
	Capacity from Fig. 2 =	$M_{No} = M_1 =$ 230 pch
____	Shared Lane – See Step 3	
____	No Shared Lane Demand =	$C_R =$ 47 pch
	Available Reserve =	$M_1 - C_R =$ 183 pch
	Delay & Level of Service (Table 3)	Long Traffic Delays D
Step 2	**Left Turn from B**	B_L
	Conflicting Flows = M_H = (from Fig. 1)	$A_R + A_T =$ ____ + ____ = ____ vph
	Critical Gap from Table 2 T_g =	____ sec
	Capacity from Fig. 2 =	$M_{No} = M_2 =$ ____ pch
	Demand =	$B_L =$ ____ pch
	Capacity Used =	$100 (B_L/M_2) =$ ____ %
	Impedance Factor from Fig. 3 =	$P_2 =$ ____
	Available Reserve =	$M_2 - B_L =$ ____ pch
	Delay & Level of Service (Table 3)	____
Step 3	**Left Turn from C**	C_L
	Conflicting Flows = M_H = (from Fig. 1)	$\frac{1}{2}A_R + A_T + B_L + B_T =$ 0 + 887 + 0 + 664 = 1551 vph
	Critical Gap from Table 2 T_g =	8.0 sec
	Capacity from Fig. 2 =	$M_{No} =$ 45 pch
	Adjust for Impedance	$M_{No} \times P_2 = M_3 =$ 45 pch
____	No Shared Lane Demand =	$C_L =$ 26 pch
	Available Reserve =	$M_3 - C_L =$ 19 pch
	Delay & Level of Service (Table 3)	Very long Traffic Delays E
	Shared Lane Demand =	$C_R + C_L = C_{RL} =$ 73 pch
____	Shared Lane with Right Turn Capacity of Shared Lane =	$M_{13} = \frac{(C_R + C_L)}{(C_R/M_1) + (C_L/M_3)}$ $M_{13} =$ 93 pch
	Available Reserve =	$M_{13} - C_{RL} =$ 20 pch
	Delay & Level of Service (Table 3)	Very Long Traffic Delays E

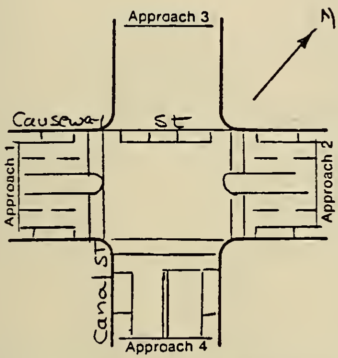
Overall Evaluation ______

Critical Movement Analysis: PLANNING
Calculation Form 1

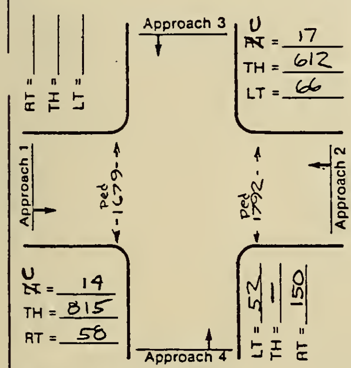
Intersection CAUSEWAY ST AT CANAL ST. **Design Hour** 1987 PM PH

Problem Statement Find 1987 LOS

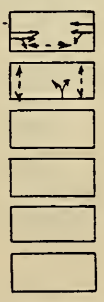
Step 1. Identify Lane Geometry



Step 2. Identify Volumes, in vph



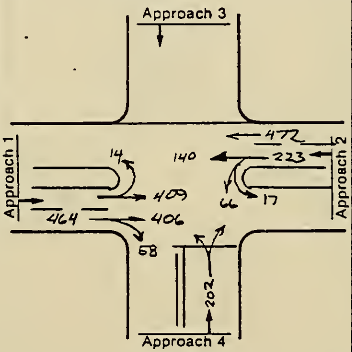
Step 3. Identify Phasing



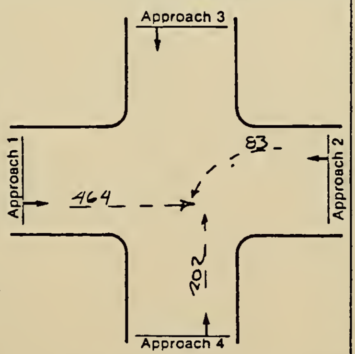
Step 4. Left Turn Check

	Approach 1	Approach 2	Approach 3	Approach 4
a. Number of change intervals per hour		60		
b. Left turn capacity on change interval, in vph		120		
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

Step 5. Assign Lane Volumes, in vph



Step 6a. Critical Volumes, in vph (two phase signal)



Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Step 7. Sum of Critical Volumes

464 + 83 + 500 or 202 + ____

= 1049 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

B

Step 9. Recalculate

Geometric Change ____

Signal Change ____

Volume Change ____

Comments

* Assume 25 second side street phase for pedestrians.

Assume 60 second cycle.

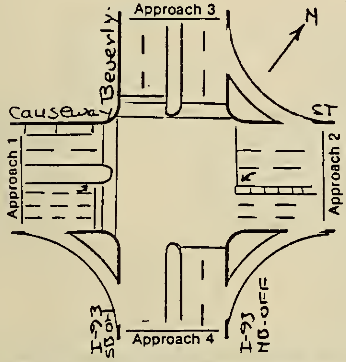
25/60 X 1200 = 500. Use 500 vehicles for vehicle equivalent of side street ped movement

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection CAUSEWAY ST. AT BEVERLY ST. AND I-93 RAMPS **Design Hour** 1987 PM P[...]

Problem Statement Find 1987 LOS

Step 1. Identify Lane Geometry



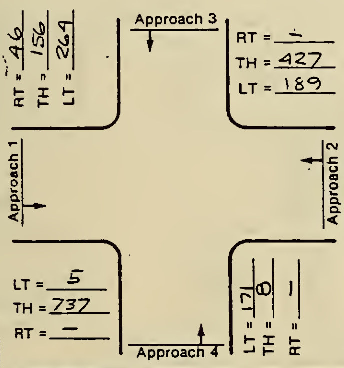
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour	40	40	40	40
b. Left turn capacity on change interval, in vph	80	80	80	80
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

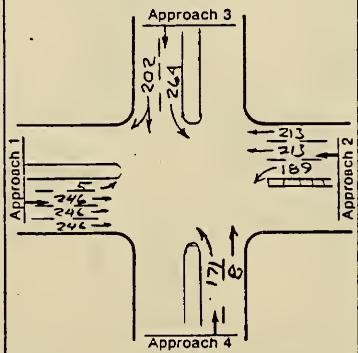
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

189 + 246 + 202 + 171

= 808 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

A

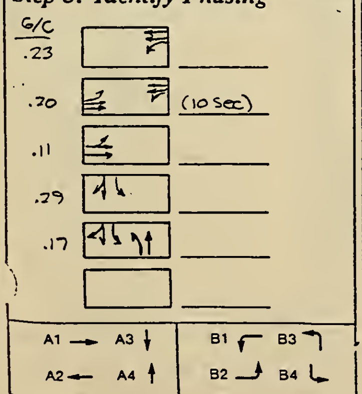
Step 9. Recalculate

Geometric Change ______

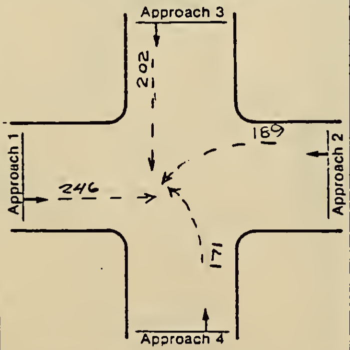
Signal Change ______

Volume Change ______

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



Comments

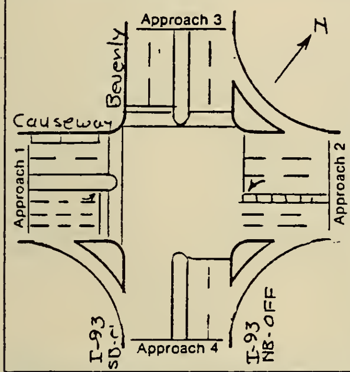
Critical Movement Analysis: PLANNING

Calculation Form 1

Intersection CAUSEWAY ST. AT BEVERLY ST. AND I-93 RAMPS **Design Hour** 2000 PM PH

Problem Statement FIND 2000 LOS

Step 1. Identify Lane Geometry



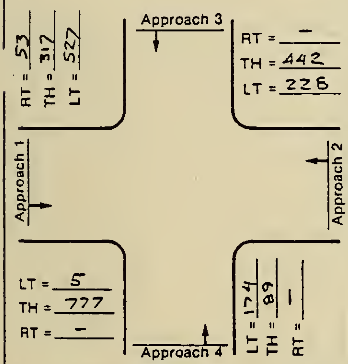
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

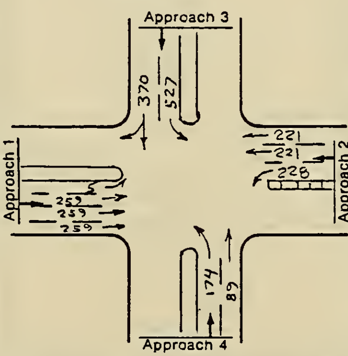
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

228 + 259 + 527 + 89

= 1103 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

C

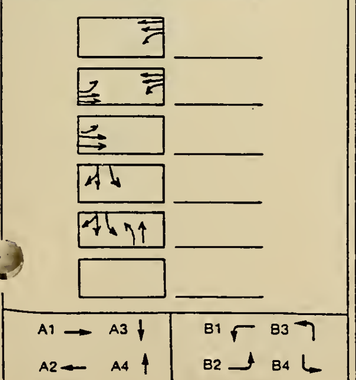
Step 9. Recalculate

Geometric Change __________

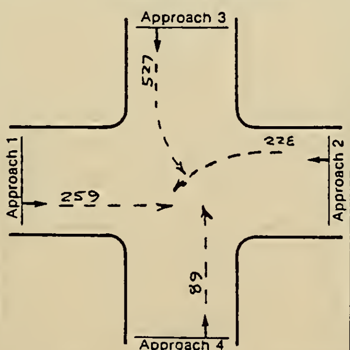
Signal Change __________

Volume Change __________

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



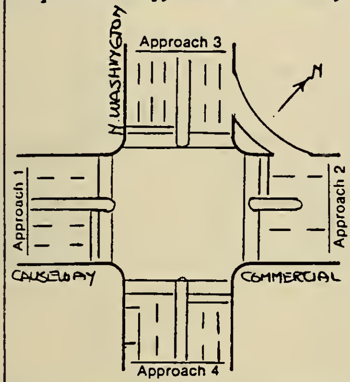
Comments

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection CAUSEWAY ST. AT NORTH WASHINGTON ST AND COMMERCIAL STREET **Design Hour** 1987 PM PH

Problem Statement Find 1987 LOS - PROPOSED PHASING

Step 1. Identify Lane Geometry



Step 4. Left Turn Check

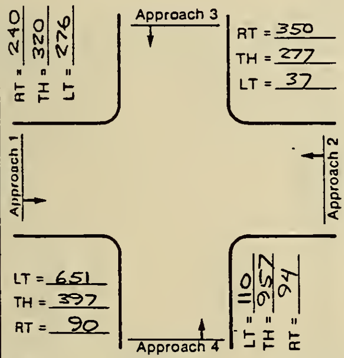
	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

Step 6b. Volume Adjustment for Multiphase Signal Overlap

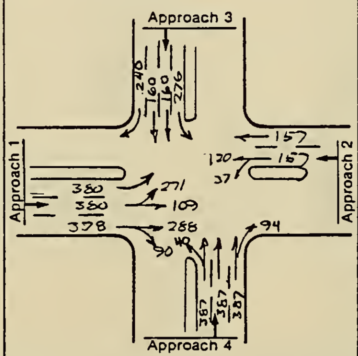
Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

4 ϕ

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

387 + 157 + 380 + 276

= 1200 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

D

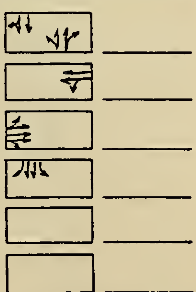
Step 9. Recalculate

Geometric Change ______

Signal Change ______

Volume Change ______

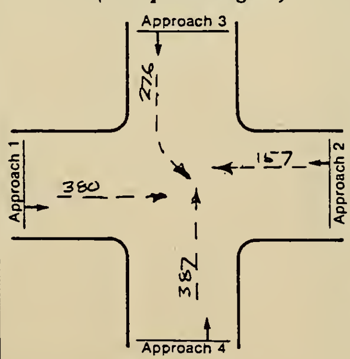
Step 3. Identify Phasing



A1 → A3 ↓ B1 B3

A2 ← A4 ↑ B2 B4

Step 6a. Critical Volumes, in vph (two phase signal)



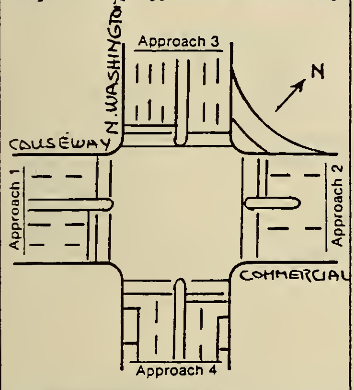
Comments

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection CAUSEWAY ST. AT NORTH WASHINGTON ST AND COMMERCIAL ST. **Design Hour** 1987 PM PH

Problem Statement Find 1987 LOS - EXISTING PHASING

Step 1. Identify Lane Geometry



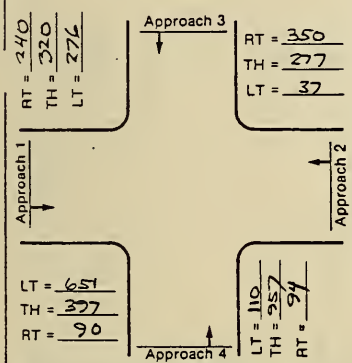
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour			30	30
b. Left turn capacity on change interval, in vph			60	60
c. G/C Ratio			.47	.47
d. Opposing volume in vph			1051	560
e. Left turn capacity on green, in vph			-487	4
f. Left turn capacity in vph (b + e)			60	64
g. Left turn volume in vph			276	110
h. Is volume > capacity (g > f)?			yes	yes

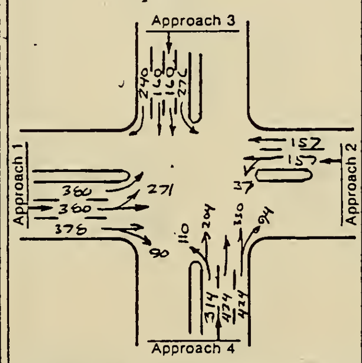
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
4 Φ			

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

424 + 276 + 380 + 157 + 50① = 1287 vph

Step 8. Intersection Level of Service
(compare Step 7 with Table 6)

E

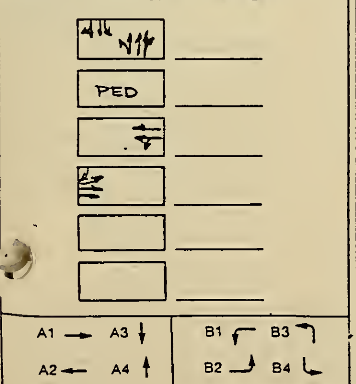
Step 9. Recalculate

Geometric Change ______

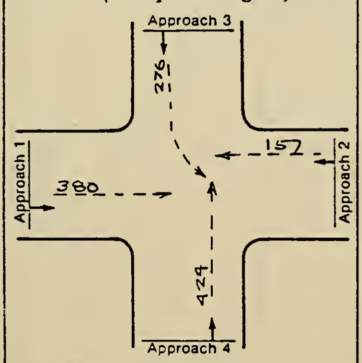
Signal Change ______

Volume Change ______

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



Comments

-Left turn check shows serious capacity deficiencies for N. Washington St left turns

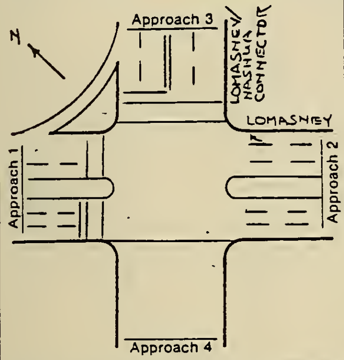
① Vol equivalent for a ped. phase timed every four cycles

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection LOMASNEY WAY at LOMASNEY/NASHUA CONN. **Design Hour** 1987 PM PH

Problem Statement FIND 1987 LOS

Step 1. Identify Lane Geometry



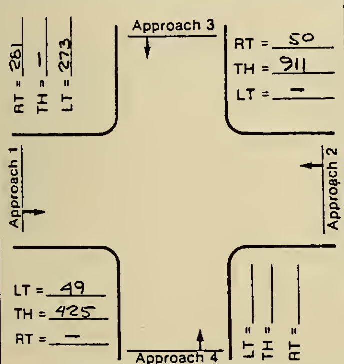
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour	40			
b. Left turn capacity on change interval, in vph	80			
c. G/C Ratio	.80			
d. Opposing volume in vph	961			
e. Left turn capacity on green, in vph	0			
f. Left turn capacity in vph (b + e)	80			
g. Left turn volume in vph	49			
h. Is volume > capacity (g > f)?	no ①			

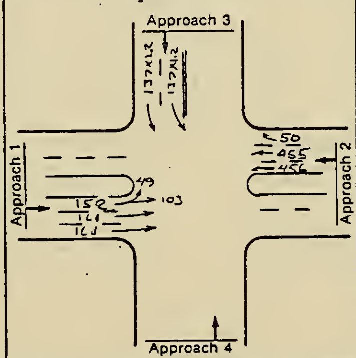
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

90 + 164 + 456 + ____

= 710 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

A

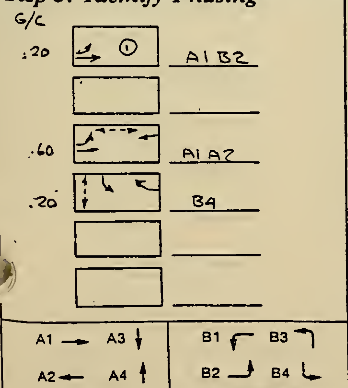
Step 9. Recalculate

Geometric Change ____

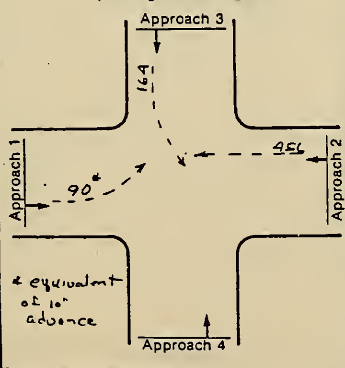
Signal Change ____

Volume Change ____

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



* equivalent of 10" advance

Comments

① First phase to be 10 second advance.

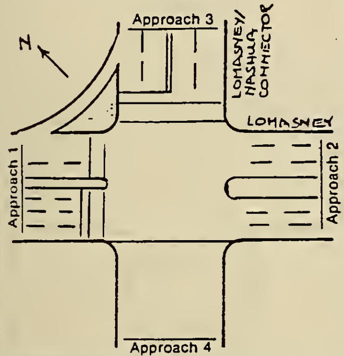
① This phase will be exclusive left turn phase when traffic volumes warrant it (year 2000)

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection LOMASNEY WAY at LOMASNEY/NASHUA CONNECTOR **Design Hour** 2000 PM PH

Problem Statement FIND 1987 LOS

Step 1. Identify Lane Geometry



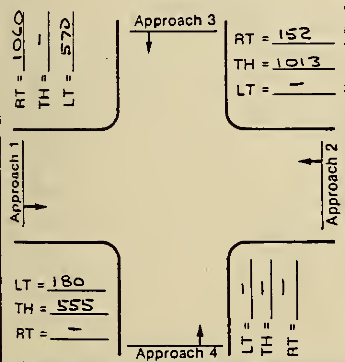
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour	40			
b. Left turn capacity on change interval, in vph	80			
c. G/C Ratio	.75			
d. Opposing volume in vph	1165			
e. Left turn capacity on green, in vph	0			
f. Left turn capacity in vph (b + e)	80			
g. Left turn volume in vph	180			
h. Is volume > capacity (g > f)?	yes			

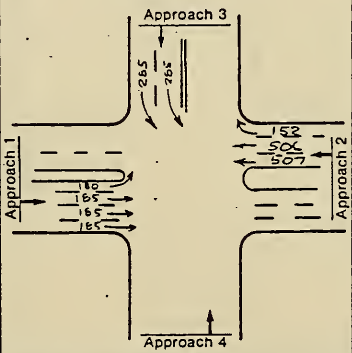
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

180 + 507 + 285 + ____

= 972 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

B

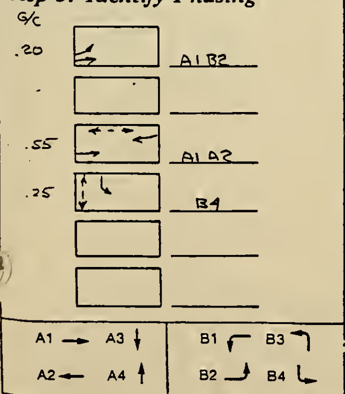
Step 9. Recalculate

Geometric Change ____

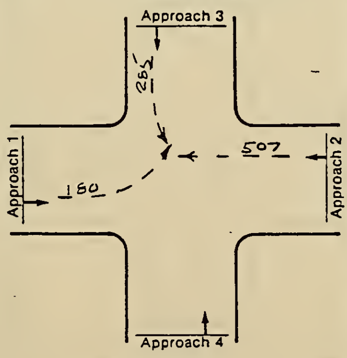
Signal Change ____

Volume Change ____

Step 3. Identify Phasing



Step 6a. Critical Volumes, in vph (two phase signal)



Comments

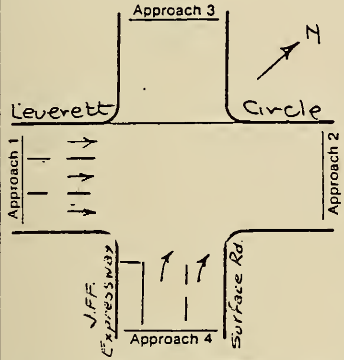
* equivalent of pedestrian movement actuated every four phases

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection Leverett Circle at J F.F. Expressway Surface Rd. **Design Hour** 1987 PM PH

Problem Statement Find 1987 LOS

Step 1. Identify Lane Geometry



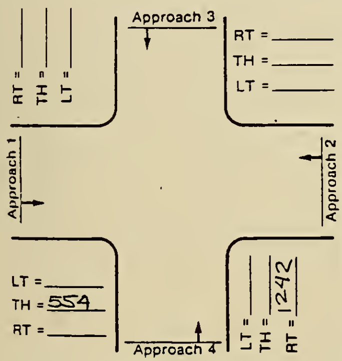
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

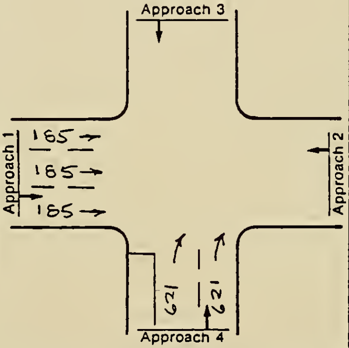
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

③ use 1055 (ie 621×1.7)

~~185~~ + 621 + ______ + ______

= 1676 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

F

Step 9. Recalculate

Geometric Change ____________

Signal Change ____________

Volume Change ____________

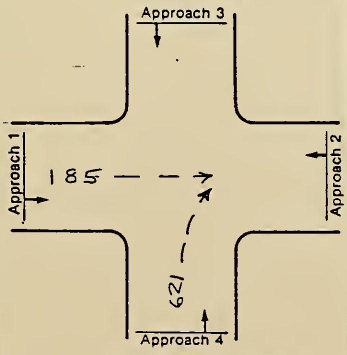
Step 3. Identify Phasing

Phase	
→ ①	A1
↗ ②	A4

A1 → A3 ↓ B1 B3

A2 ← A4 ↑ B2 B4

Step 6a. Critical Volumes, in vph (two phase signal)



Comments

① Timed concurently with Charles St phase of Charles St @ Leuevett Circle Signals

② Timed concurrently with Leuevett Circle phase of Charles St @ Leuevett Circle

③ this assumes no time restraints (free operation) which is not the case. The time ratio (therefore the volume ratio) of A1 to A4 is approx 1.7, the time ratio of Charles St to Leverett Circle at that intersection

Table V-1

North Station Urban Renewal Area

EXISTING LAND USE

	Sub-Area I			Sub-Area II			Total		
E	SQ.FT.	ACRES	%	SQ.FT.	ACRES	%	SQ.FT.	ACRES	%
sidential	17,424	.40	3				17,424	.40	.8
ercial	31,363	.72	5				31,363	.72	1.5
xed Residential/ Commercial	13,504	.31	2				13,504	.31	.6
i-Public*	113,256	2.60	19	176,418	4.05	11	189,674	6.65	13.4
lity				21,780	.50	1	21,780	.50	1.0
lroad				180,338	4.14	12	180,338	4.14	8.4
rking	186,001	4.27	32	480,031	11.02	31	666,032	15.29	30.8
reets	233,481	5.36	39	373,510	8.57	24	606,991	13.93	28.1
arles River				313,432	7.20	20	313,432	7.20	14.5
her Open Space				19,602	.45	1	19,602	.45	.9
TAL	595,029	13.66	100	1,565,111	35.93	100	2,160,140	49.59	100

* North Station/Boston Garden, Registry, Rehabilitation Hospital

NORTH STATION REDEVELOPMENT PROJECT

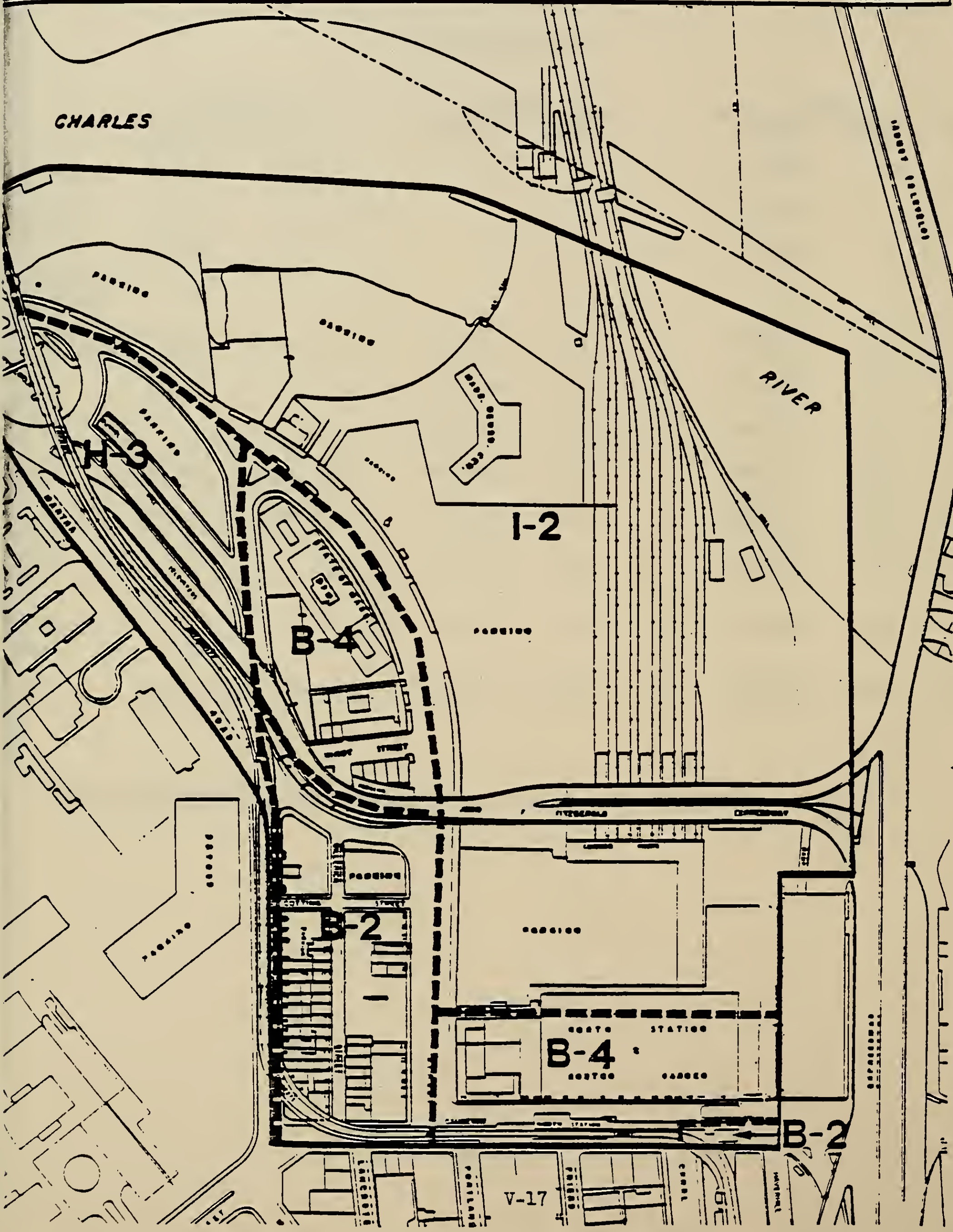
BOSTON REDEVELOPMENT AUTHORITY

EXISTING ZONING

0 200 400 FT
0 50 100 M

Figure V-8

N



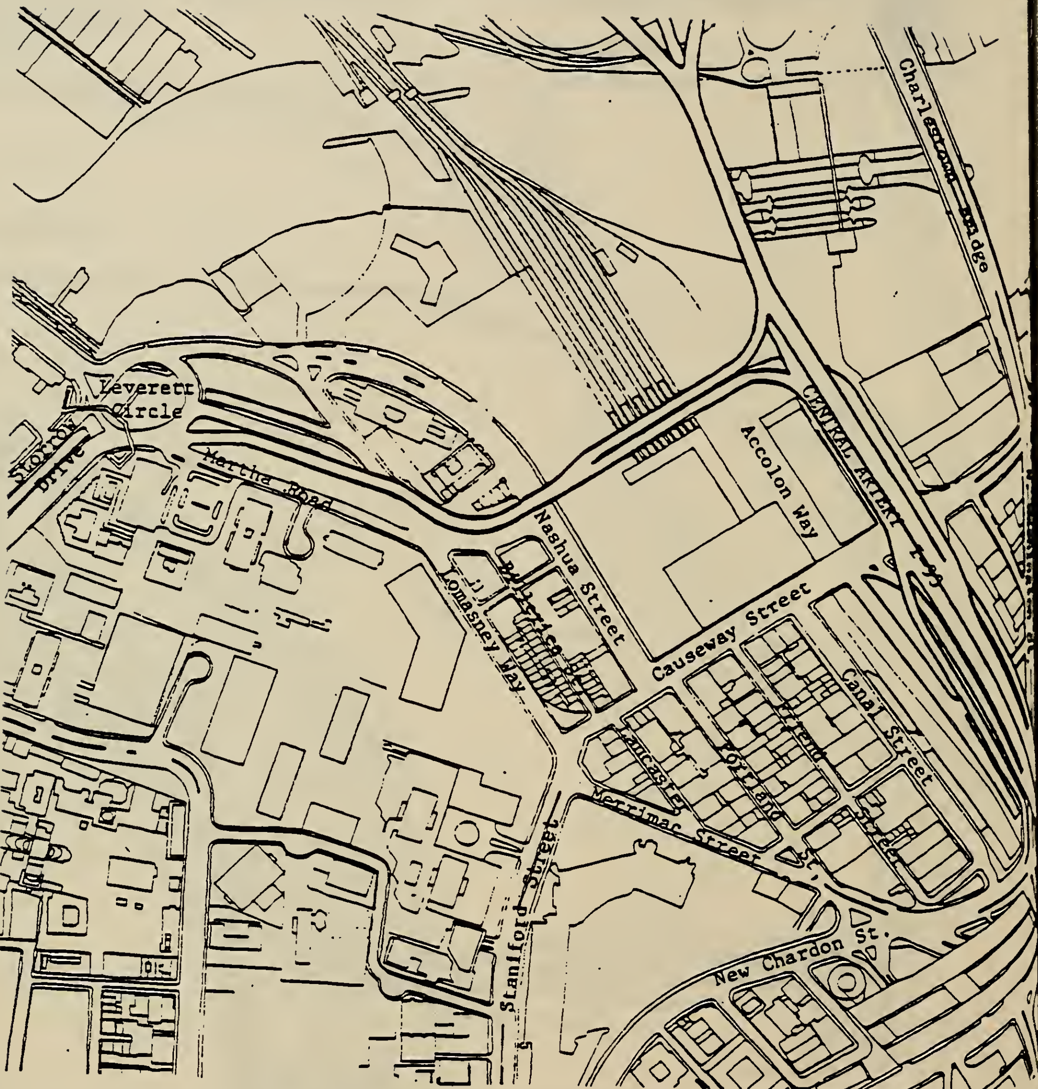


FIGURE V-9: EXISTING NORTH STATION ROADWAY SYSTEM

Table V-2

NORTH STATION URBAN RENEWAL PROJECT

Traffic Volumes on Major Project Area Streets and Access Roadways (1980)

Street	P.M. Peak (5-6 p.m.)	8-hour Peak (10 a.m.-6 p.m.)	AWDT
Central Artery (Northbound)	4,400	45,635	71,700
(Southbound)	3,140	34,295	69,000
Storrow Drive Access Ramp (On)	2,754	22,129	46,440
(Off)	2,460	23,510	47,300
Storrow Drive (Eastbound)	2,850	19,182	45,190
(Westbound)	2,786	23,311	51,897
Causeway Street	1,452	11,480	25,880
Nashua Street	1,555	11,806	20,364
Lomasney Way	202	4,053	6,041
Martha Road	280	4,617	6,603
Charles River Dam (Northbound)	1,230	6,277	17,938
(Southbound)	1,008	9,260	21,542
Merrimac Street	546	4,371	5,712
North Washington Street	1,539	9,453	16,459
Canal Street	257	2,276	5,563

Source: BRA Transportation Planning Department

FIGURE V-10

AVERAGE WEEKDAY TRAFFIC NORTH STATION PROJECT

EXISTING (1980)

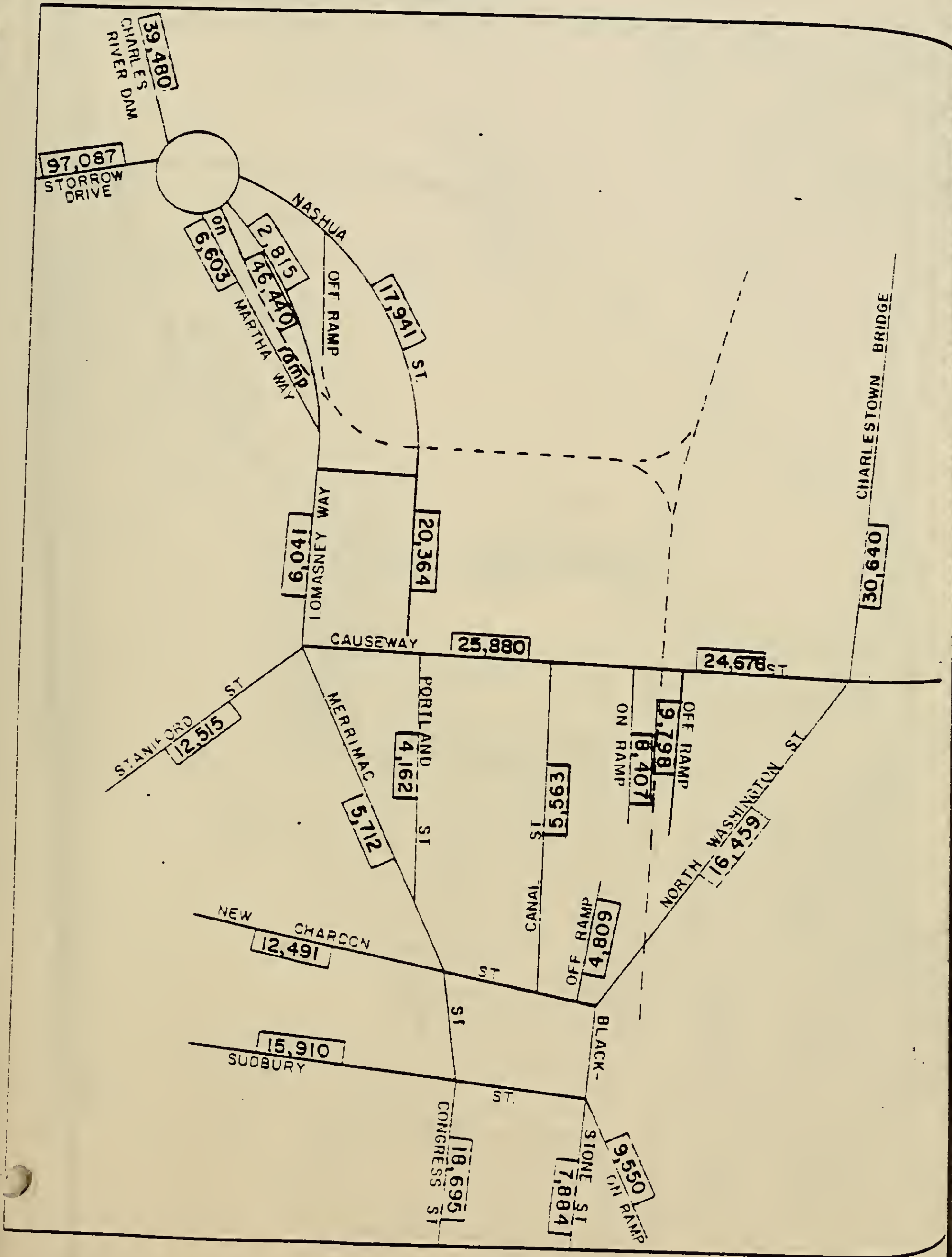


FIGURE V-11

NORTH STATION PROJECT TRAFFIC IMPACT AREA

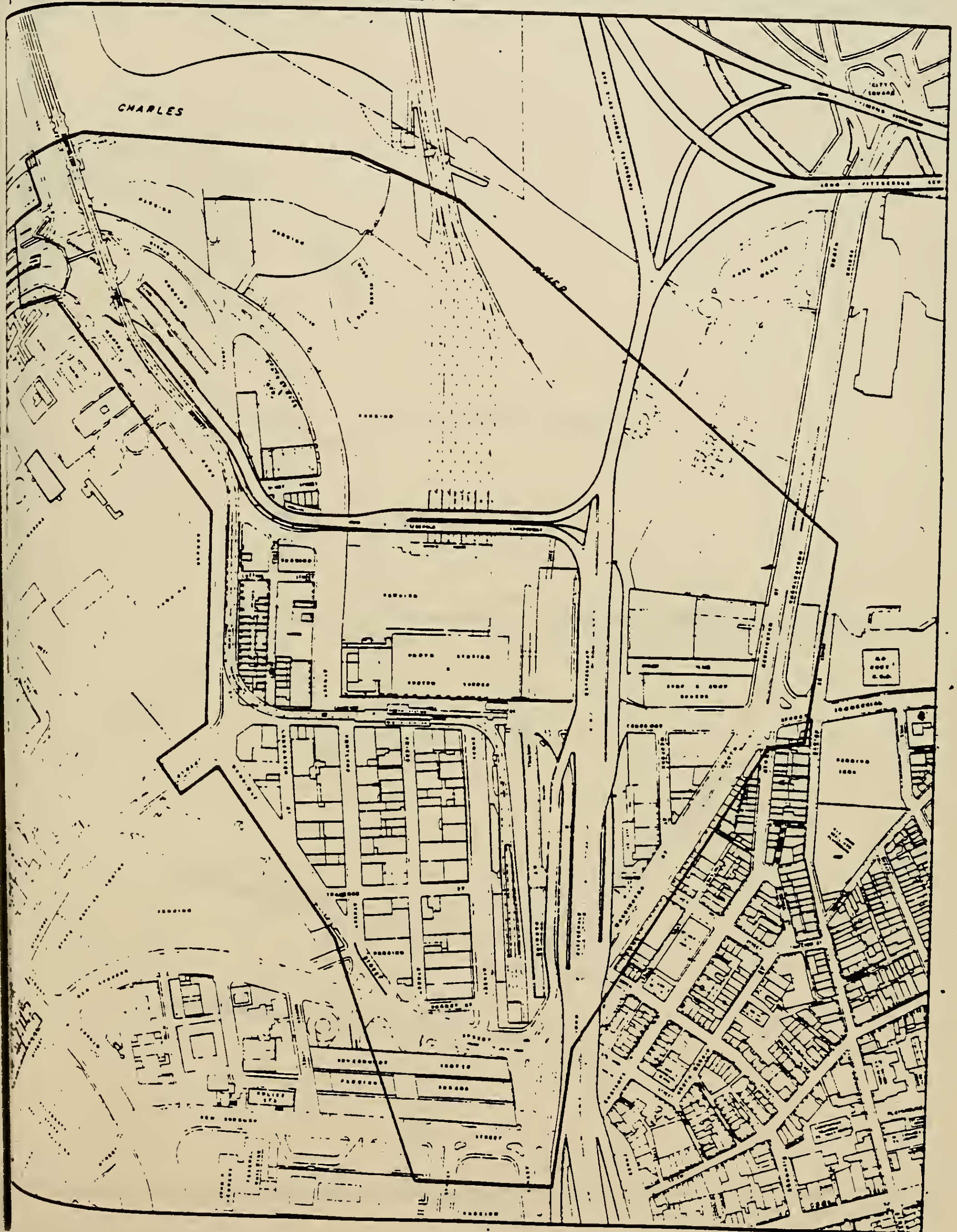
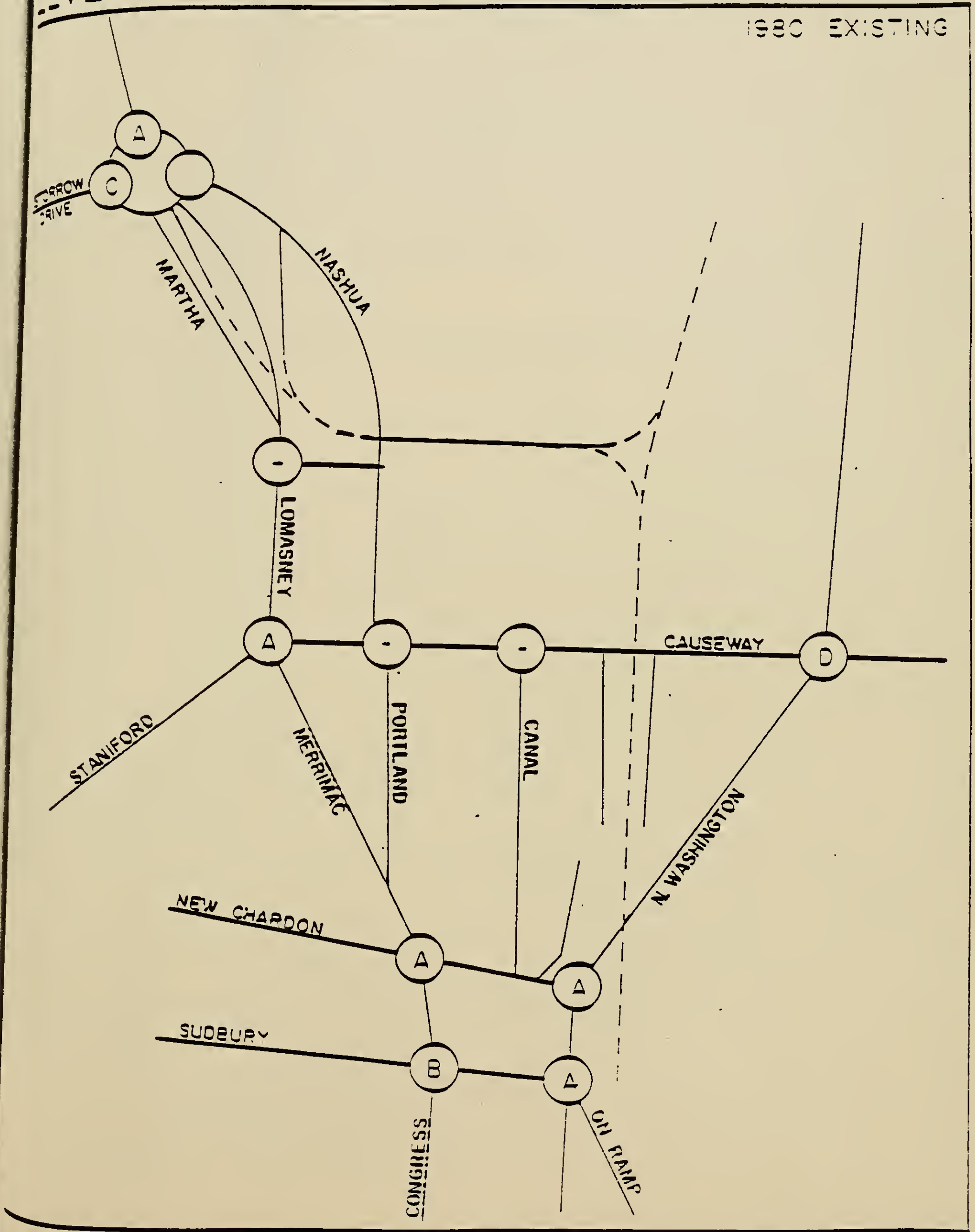


FIGURE V-12

PM PEAK HOUR LEVEL OF SERVICE ANALYSIS

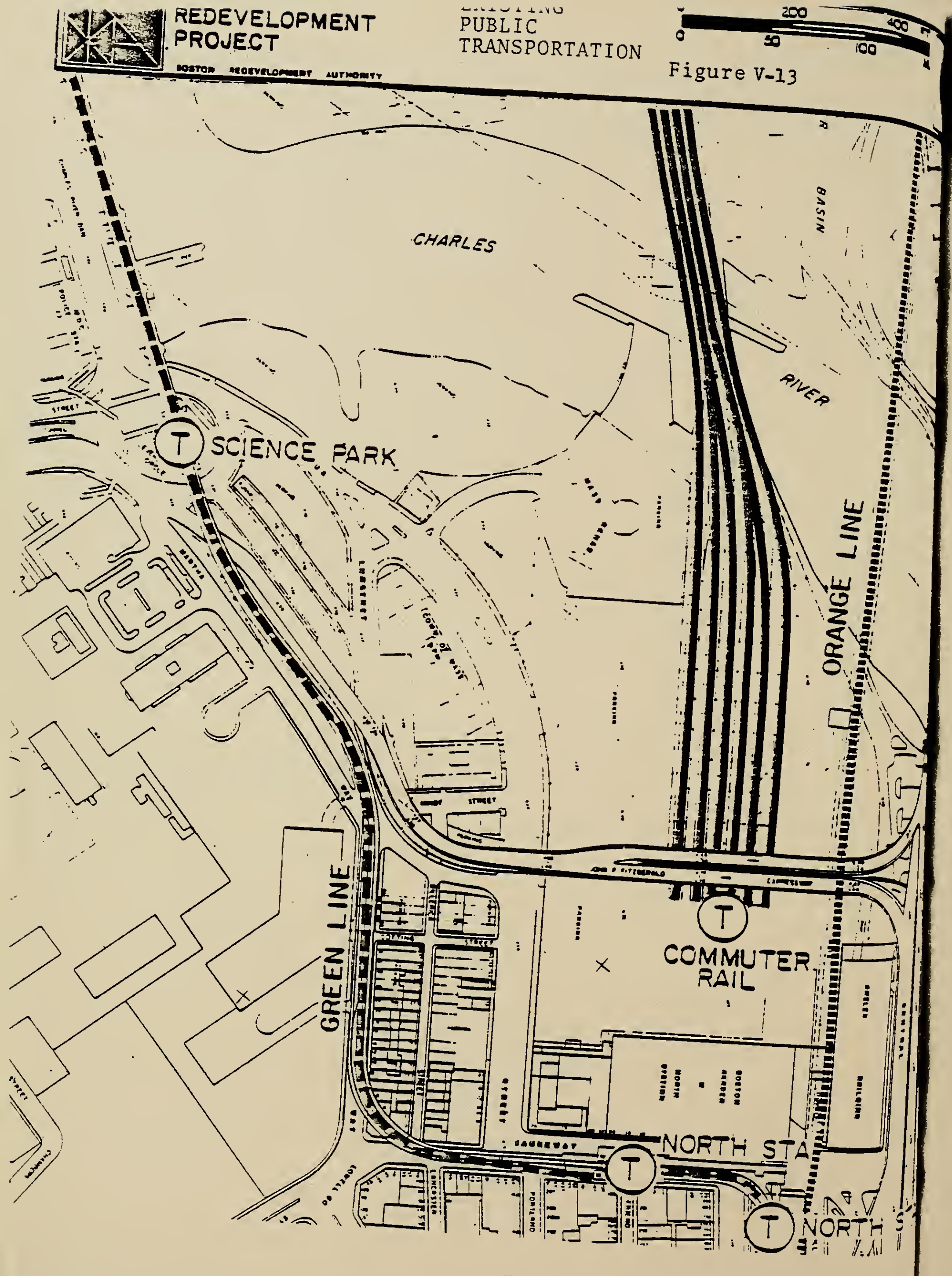


REDEVELOPMENT PROJECT

BOSTON REDEVELOPMENT AUTHORITY

EXISTING PUBLIC TRANSPORTATION

Figure V-13



Average weekday (24-hour) volume is 110 trains. During both the morning peak hours (7-9 a.m.) and the evening peak hours (4-6 p.m.), a total of 35 trains arrive at and leave from North Station. Total average weekday ridership (1982) is 20,320 persons.

No MBTA bus routes directly serve the project area. However, several MBTA buses, both local and express, and private commuter bus lines which serve cities and towns outside of the Metropolitan Boston area are available at Haymarket station, a short walk from the North Station area.

Table V-4 below shows the current daily loadings of the public transportation facilities serving the North Station area.

Table V-4

Average Daily Boardings - North Station Area

Orange Line (1978)	
North Station	4,186
Green Line (1978)	
Science Park	722
North Station (elevated)	1,659
North Station (surface)	2,059
Commuter Rail (1982)	10,314
TOTAL	18,940

Source: MBTA

3.3 Parking Facilities

Within the North Station project area there currently exist a total of 2,332 off-street parking spaces (see Table V-5 and Figure V-14).

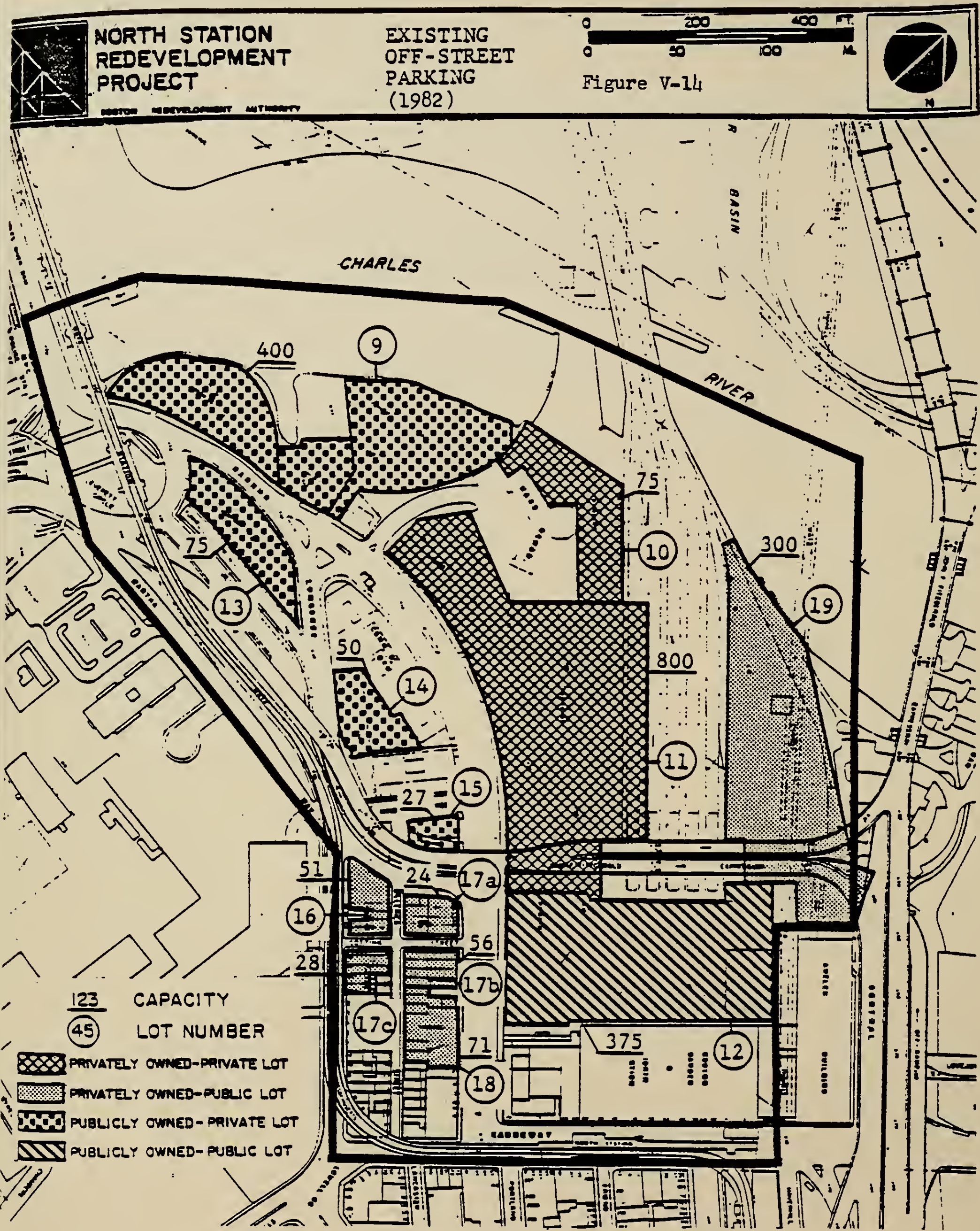
Approximately 39% of these spaces, or 905 spaces, are open to the public, 375 spaces being located in a City of Boston-owned lot and the remainder in privately-owned lots. The remaining parking is primarily employee parking, principally for the Massachusetts Department of Public Works (552 spaces) and the Massachusetts General Hospital (800 spaces).

NORTH STATION REDEVELOPMENT PROJECT

BOSTON REDEVELOPMENT AUTHORITY

EXISTING OFF-STREET PARKING (1982)

Figure V-14

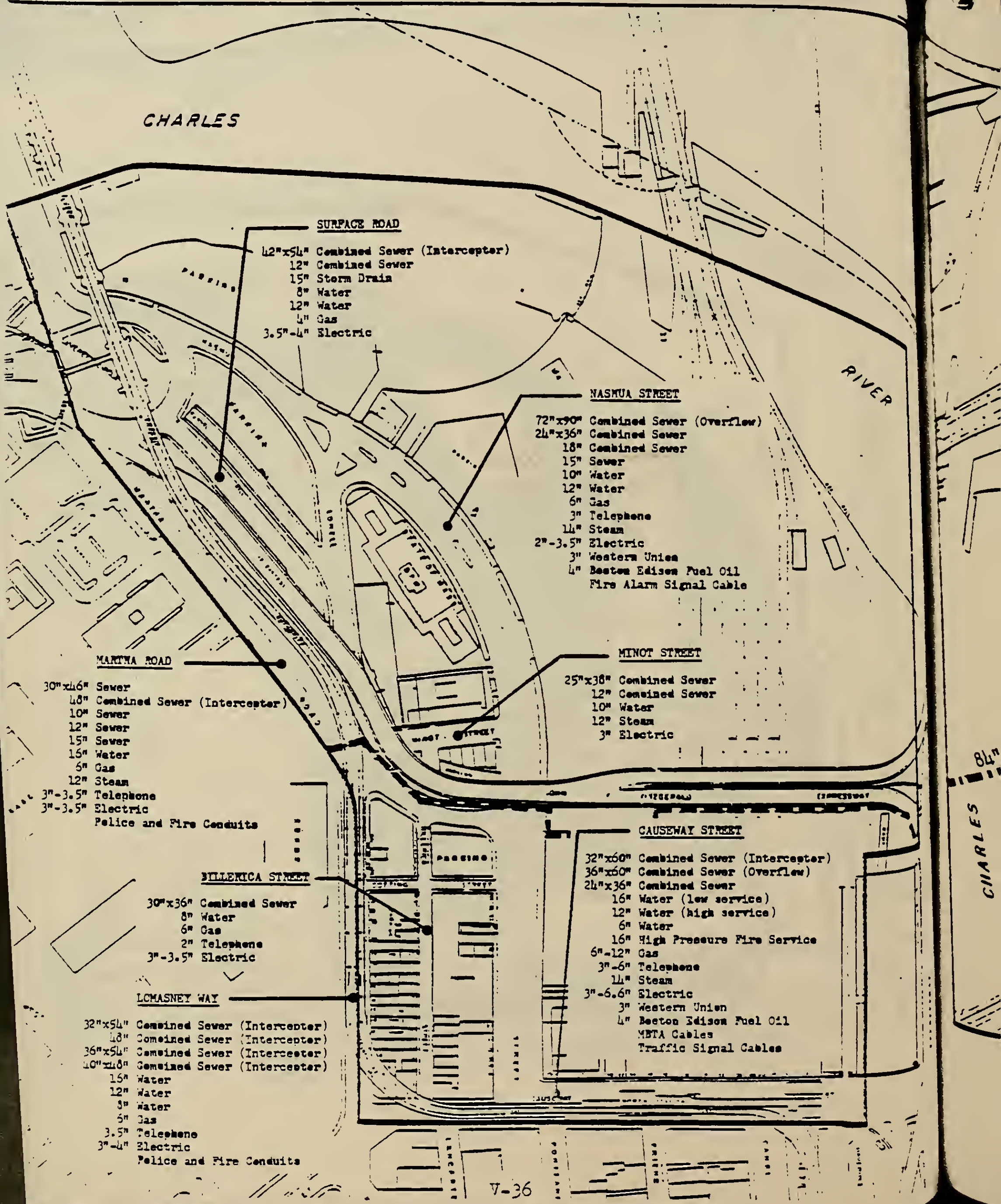


NORTH STATION REDEVELOPMENT PROJECT

BOSTON REDEVELOPMENT AUTHORITY

EXISTING UTILITIES (1982)

Figure V-15



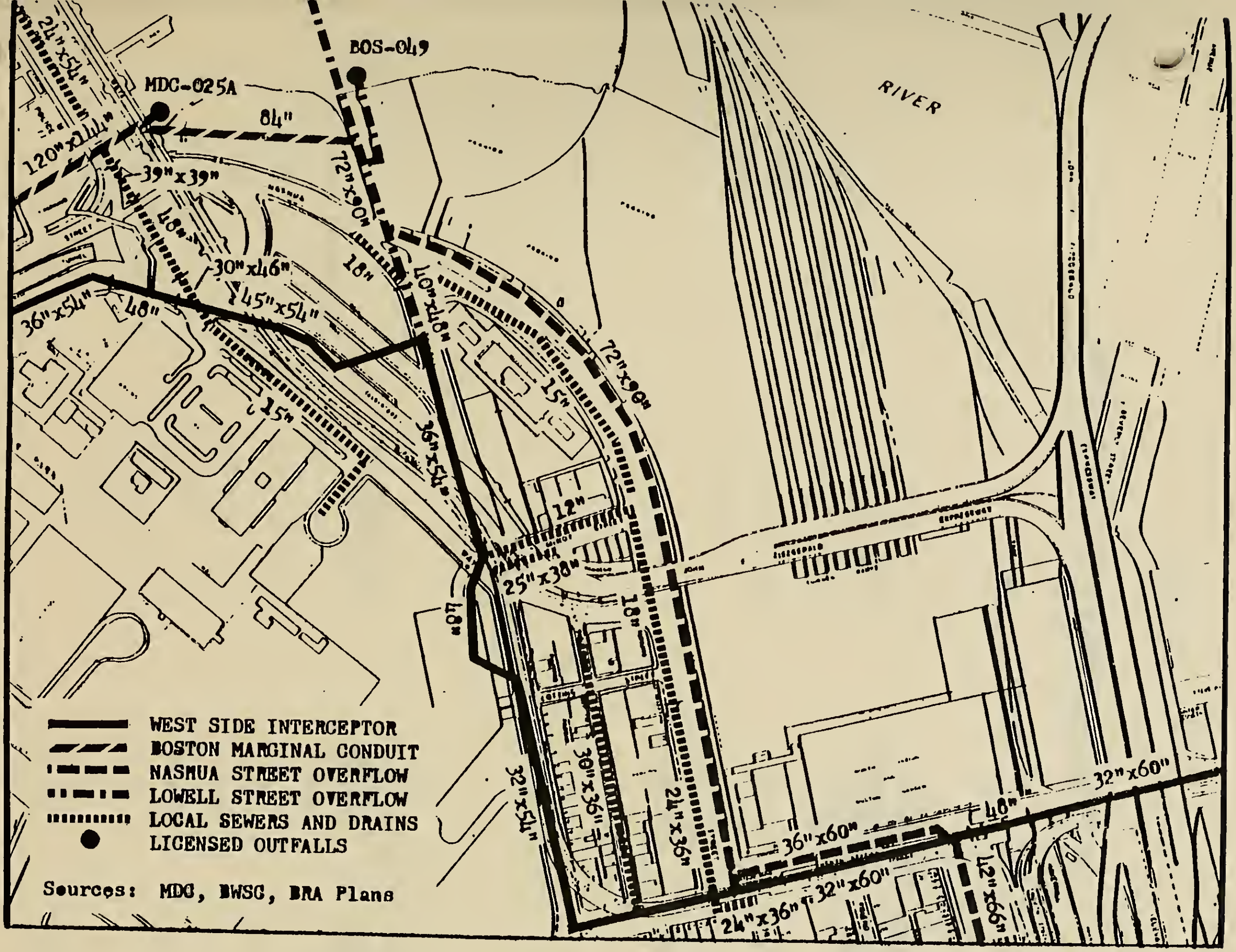


Figure V-16: MAJOR COMBINED SEWER AND STORM DRAINS

TABLE VI.C-2

NORTH STATION AVERAGE WEEKDAY TRIP GENERATION

Phase I

	Arrival Rates Per Day	Daily Person Arrivals Alternate 1 (Office)	Alternate 2 (Hotel)
Retail/Commercial	18.3/1,000 s.f.	2,290	2,290
Office	7.3/1,000 s.f.	8,760	5,840
Hotel	4.6/Room	-	1,600
		11,050	9,730

Phase II

	Arrival Rates Per Day	Daily Person Arrivals Perferred Program	Optional Program
Retail/Commercial	18.3/1,000 s.f.	1,650	457
Office	7.3/1.000 s.f.	-	3,576
Hotel	4.6/Room	1,840	-
Residential	4.0/Unit	4,400	1,200
Public/Museum	10.0/1,000 s.f.	1,484	-
Hospital	4.0/Bed	-	1,140
		9,374	6,373

TABLE VI.C-3

EMPLOYEE/NON-EMPLOYEE PERSON TRIPS

	% of Trips	Average Weekday Person Arrivals		
		Phase I	Phase II	
			Preferred	Optional
Retail				
Employee	15	343	247	69
Non-employee	85	1946	1403	388
Office				
Employee	66	5781	-	2360
Non-employee	34	2979	-	1216
Hotel				
Employee	24	-	442	-
Non-employee	76	-	1398	-
Residential				
Employee	2	-	88	24
Non-employee	98	-	4312	1176
Public/Museum				
Employee	5	-	58	-
Non-employee	95	-	1426	-
Hospital				
Employee	66	-	-	750
Non-employee	34	-	-	390
TOTAL				
Employee	178	6124	835	3203
Non-employee	422	4925	8539	3170
	600	11047	9374	6373

TABLE VI.C-4

PERCENTAGE OF AVERAGE WEEKDAY TRIPS DURING PEAK HOURS AND PRIME OFF-PEAK HOUR

	ARRIVE			DEPART		
	8-9 A.M.	OFF-PEAK	5-6 P.M.	8-9 A.M.	OFF-PEAK	5-6 P.M.
Retail						
Employee	10	12	10	0	12	20
Non-employee	0	10	5	0	10	10
Office						
Employee	55	2	0	0	2	55
Non-employee	10	15	0	0	15	10
Hotel						
Employee	5	5	0	0	5	5
Non-employee	7	8	3	3	8	7
Residential						
Employee	25	5	5	5	5	25
Non-employee	0	5	55	55	5	0
Public/Museum						
Employee	10	12	10	0	12	20
Non-employee	0	12	10	0	12	20
Hospital						
Employee	50	30	0	10	30	50
Non-employee	10	10	10	10	10	10

TABLE VI.C-5

PEAK HOUR AND OFF-PEAK HOUR PERSON TRIPS

	ARRIVALS			DEPARTURES		
	A.M.	Off	P.M.	A.M.	Off	P.M.
Phase I						
Retail/Commercial						
Employees	34	41	34	0	41	69
Non-Employees	0	194	97	0	194	194
Office						
Employees	3180	116	0	0	116	3180
Non-Employees	298	447	0	0	497	298
	3512	798	131	0	798	3741
Phase II Preferred						
Retail/Commercial						
Employees	25	30	25	0	30	49
Non-Employees	0	140	70	0	140	140
Hotel						
Employees	22	22	0	0	22	22
Non-Employees	100	112	42	42	112	100
Residential						
Employees	22	4	4	4	4	22
Non-Employees	0	216	2372	2372	216	0
Public/Museum						
Employees	6	70	6	0	70	12
Non-Employees	0	171	109	0	171	285
	173	877	2628	2418	877	563
TOTAL	3687	1675	2759	2418	1675	4304
Phase II Optional						
Retail/Commercial						
Employees	7	8	7	0	8	14
Non-Employees	0	39	19	0	39	39
Office						
Employees	1298	47	0	0	47	1298
Non-Employees	122	182	0	0	182	122
Residential						
Employees	6	1	1	1	1	6
Non-Employees	0	55	604	604	55	0
Hospital						
Employees	375	225	0	75	225	375
Non-Employees	39	39	39	39	39	39
	1847	596	670	719	596	1893
TOTAL	5359	1394	801	719	1394	5634

Among the considerations incorporated in the modal split percentages are the following specific data describing modal splits currently experienced in Downtown Boston.

- At Jordan Marsh's downtown store, 12% of the employees walk to work, 71% use transit, and 15% drive.

- The proportions of office workers using transit or commuter rail are as follows:

- First National Bank	73%
- State Street Bank	68%
- Liberty Mutual	41%
- John Hancock	54%
- Prudential	31%
- Hurley Building	50%
- John F. Kennedy Building	57%

Table VI.C-6 summarizes the above discussion and statistics as applied to the North Station project.

Vehicle Occupancy

Vehicle occupancy rate - the average number of riders per car - varies by trip purpose. Average auto occupancy rates in downtown Boston are as follows:

	Persons/Vehicle	
	Employees	Non-Employees
Office	1.23	1.11
Jordan Marsh (retail)	1.00	1.12
Statler Hilton (hotel)	1.00	1.07

The Central Transportation Planning Staff (CTPS), also using data generated by Wilbur Smith and Associates,(1) suggests that the following occupancy rates are experienced in downtown Boston:

Non-Home Based Trips	1.4 persons/vehicle
Work Trips	1.1 persons/vehicle
Home Based Non-Work Trips	1.75 persons/vehicle

The auto occupancy rates used in the traffic analysis for North Station are presented below:

TABLE VI.C-6

MODAL SPLIT

Phase I

	Percentages Auto	Percentages Transit	Percentages Walk	Average Weekday Person Arrivals Auto	Average Weekday Person Arrivals Transit	Average Weekday Person Arrivals Walk	TOTAL
Retail/Commercial							
Employee	30	60	10	102	205	34	344
Non-Employee	40	20	40	778	389	778	1945
Office							
Employee	36	54	10	2660	2814	308	5782
Non-Employee	45	40	15	1341	1191	447	2979
TOTAL				4881	4599	1567	11047

Phase II Preferred

	Auto	Transit	Walk	Auto	Transit	Walk	TOTAL
Retail/Commercial							
Employee	30	60	10	75	150	25	250
Non-Employee	40	20	40	560	280	560	1400
Hotel							
Employee	12	73	15	53	322	66	442
Non-Employee	60	25	15	838	349	210	1397
Residential							
Employee	25	60	15	22	53	13	88
Non-Employee	26	44	30	1121	1897	1294	4312
Public/Museum							
Employee	30	60	10	17	35	6	58
Non-Employee	40	50	10	570	713	143	1425
TOTAL				3144	3614	2283	9144

Phase II Optional

	Auto	Transit	Walk	Auto	Transit	Walk	TOTAL
Retail/Commercial							
Employee	30	60	10	21	41	7	69
Non-Employee	40	20	40	155	78	155	388
Office							
Employee	36	54	10	850	1274	236	2360
Non-Employee	45	40	13	547	486	182	1216
Residential							
Employee	25	60	15	6	14	4	24
Non-Employee	26	44	30	306	517	353	1176
Hospital							
Employee	40	50	10	300	375	75	750
Non-Employee	50	40	10	195	156	39	390
TOTAL				2378	2939	1041	6373

TABLE VI.C-7

AVERAGE WEEKDAY DAILY NORTH STATION VEHICULAR TRAFFIC ARRIVALS

	Vehicles		
	Phase I	Phase II	
		Preferred	Optional
Retail/Commercial			
Employee	73	53	15
Non-Employee	409	295	82
Office			
Employee	1784	--	629
Non-Employee	1219	--	497
Luxury Hotel			
Employee	--	35	--
Non-Employee	--	524	--
Residential			
Employee	--	17	5
Non-Employee	--	1019	259
Public/Museum			
Employee	--	13	--
Non-Employee	--	248	--
Hospital			
Employee	--	--	214
Non-Employee	--	--	59
TOTAL			
Employee	1857	118	863
Non-Employee	1628	2086	896
	3485	2204	1759

Auto Occpancy Rates

	Retail	Office	Public/ Hotel	Residential	Museum	Hospital
Employees	1.4	1.5	1.3	1.3	1.3	1.4
Non-Employees	1.9	1.1	1.4	1.1	2.3	1.6

1.4 Future Traffic Demand and Impacts

Average Weekday Project-Related Vehicular Traffic

Applying the vehicle occupancy rates to daily person trips by auto yields the daily site-generated traffic, as indicated in Table VI.C-7. Peak hour site-generated traffic by direction is presented in Table VI.C-8, determined by applying the values of Table VI.C-4 to Table VI.C-7.

Approach Sectors

Trips to and from the North Station area were allocated to approach streets on the basis of data compiled in the 1977 Origin and Destination Survey for the Boston Central Artery (5) prepared by the Massachusetts Department of Public Works, supplemented by up-to-date intersection turning movement counts taken at 15 locations within the North Station Traffic Impact Area (Figure V-12). The North Station Traffic Impact Area has been defined, by EOEA, to include the proposed Urban Renewal Area and adjacent areas within a perimeter bounded by Merrimac Street/Lomasney Way/Martha Road, New Sudbury Street, North Washington Street, and the Charles River, including the intersections along this perimeter. This assignment is indicated in Table VI.C-9 below. Appendix H shows the percentages of site-generated traffic assigned to streets within the North Station Traffic Impact Area. The actual site-generated traffic assigned to streets within the Traffic Impact Area for each of the build alternatives also is presented in Appendix H for the P.M. peak hours and in Figures VI.C-3a through VI.C-3c for the Average Weekday Traffic.

TABLE VI.C-8 (continued)

Peak-Hour North Station Vehicular Traffic

Phase II
Optional

	A.M. Peak-Hour To	A.M. Peak-Hour From	P.M. Peak-Hour To	P.M. Peak-Hour From
Retail/Commercial				
Employee	2	0	2	3
Non-Employee	0	0	4	8
***Office**				
Employee	346	0	0	346
Non-Employee	50	0	0	50
Residential				
Employee	1	1	1	1
Non-Employee	0	143	143	0
***Hospital**				
Employee	151	30	0	151
Non-Employee	17	17	17	17
Sub-Total	567	191	167	576
TOTAL (Optional)	1672	191	194	1730

*49% of office trips and 100% of hospital trips are existing traffic from Registry Building and Massachusetts Rehabilitation Hospital.

TABLE VI.C-8

Peak-Hour North Station Vehicular Traffic

Phase I

	A.M. Peak-Hour		P.M. Peak-Hour	
	To	From	To	From
Retail/Commercial				
Employee	7	0	7	15
Non-Employee	0	0	20	41
Office				
Employee	976	0	0	976
Non-Employee	122	0	0	122
Sub-Total	1105	0	27	1154

Phase II
Preferred

	A.M. Peak-Hour		P.M. Peak-Hour	
	To	From	To	From
Retail/Commercial				
Employee	5	0	5	10
Non-Employee	0	0	15	30
Office				
Employee	345	0	0	345
Non-Employee	50	0	0	50
Luxury Hotel				
Employee	2	0	0	2
Non-Employee	37	16	16	37
Residential				
Employee	4	1	1	4
Non-Employee	0	560	560	0
Public/Museum				
Employee	1	0	1	3
Non-Employee	0	0	25	50
Sub-Total	394	576	622	481
TOTAL (Preferred)	1499	576	649	1635

FIGURE VI.C-3(a)

TRAFFIC ASSIGNMENTS NORTH STATION

PHASE I 1987

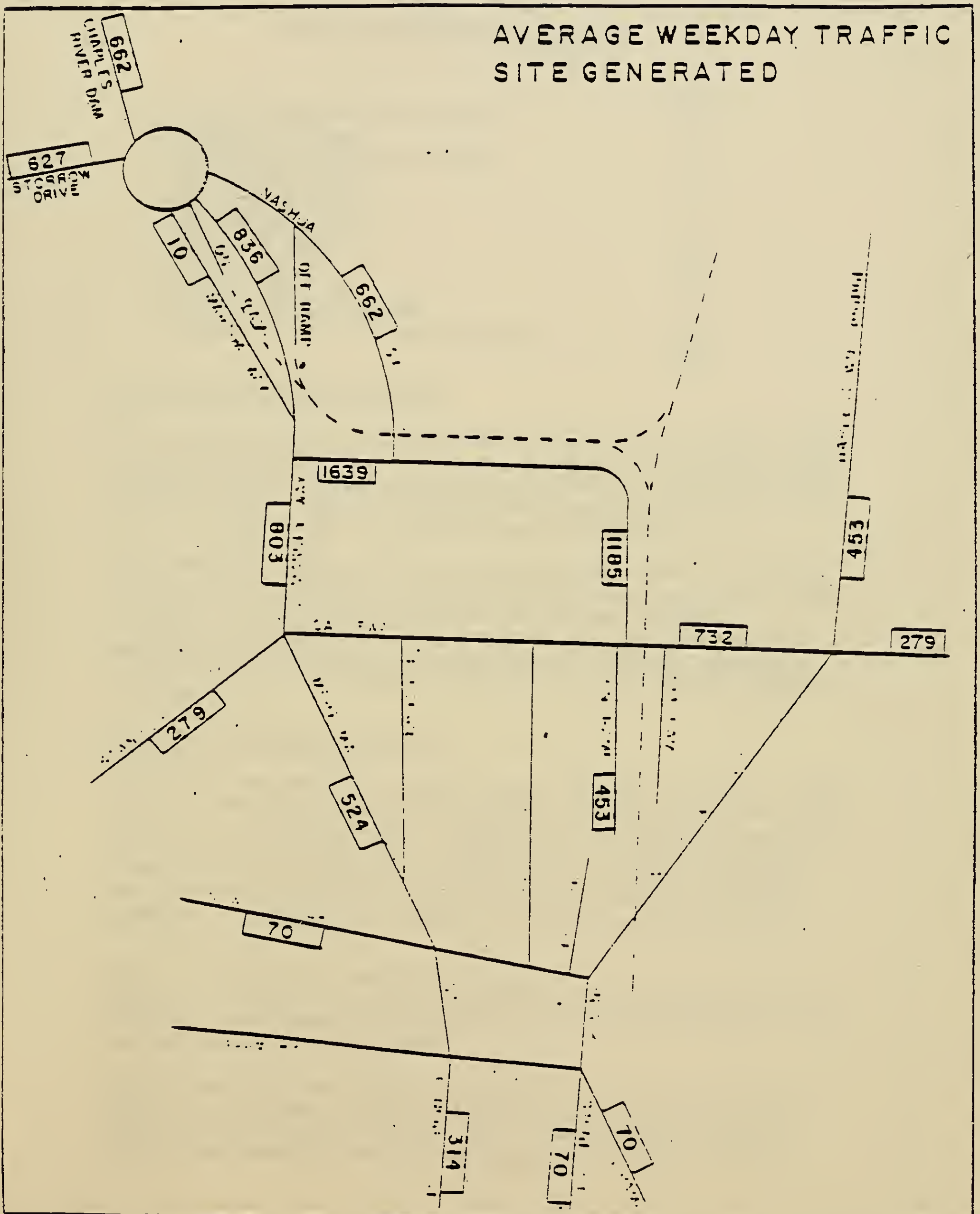


Table VI.C-9
Traffic Assignments by Approach

	%
North Washington Street Bridge	13
Commercial Street	8
Haymarket Southbound On-ramp	2
Blackstone Street	2
New Congress Street	9
New Chardon Street	2
Staniford Street	8
Storrow Drive	18
Charles River Dam	19
Leverett Circle On-ramp	6
Causeway Street Southbound On-ramp	13
	100

1987 and 2000 Traffic Volumes

Total future traffic within the North Station Traffic Impact Area has been forecasted by adding future background traffic and future project-generated traffic, for both the preferred program and the optional program. In calculating future background traffic, a uniform growth factor of 0.5% per year was utilized.

Total 1987 and 2000 P.M. Peak Hour Directional traffic volumes at intersections affected by the North Station development are presented in Table VI.C-10 for the preferred and optional programs. Figures VI.C-4a through VI.C-4e indicate 1987 and 2000 average weekday traffic volumes for the development programs (background plus site-generated), together with the No-build AWDT for comparative purposes.

Intersection Capacity Analysis

Analysis of the capacity of major street intersections in the study area was undertaken to assess the traffic impact of the North Station project on the proposed street system and on related environmental factors, such as air quality. The capacity calculations and the production of parameters required for the air quality assessment were based upon a simplified critical lane method of analyses as presented in the National Cooperative Highway Research Bulletin 187.(6)

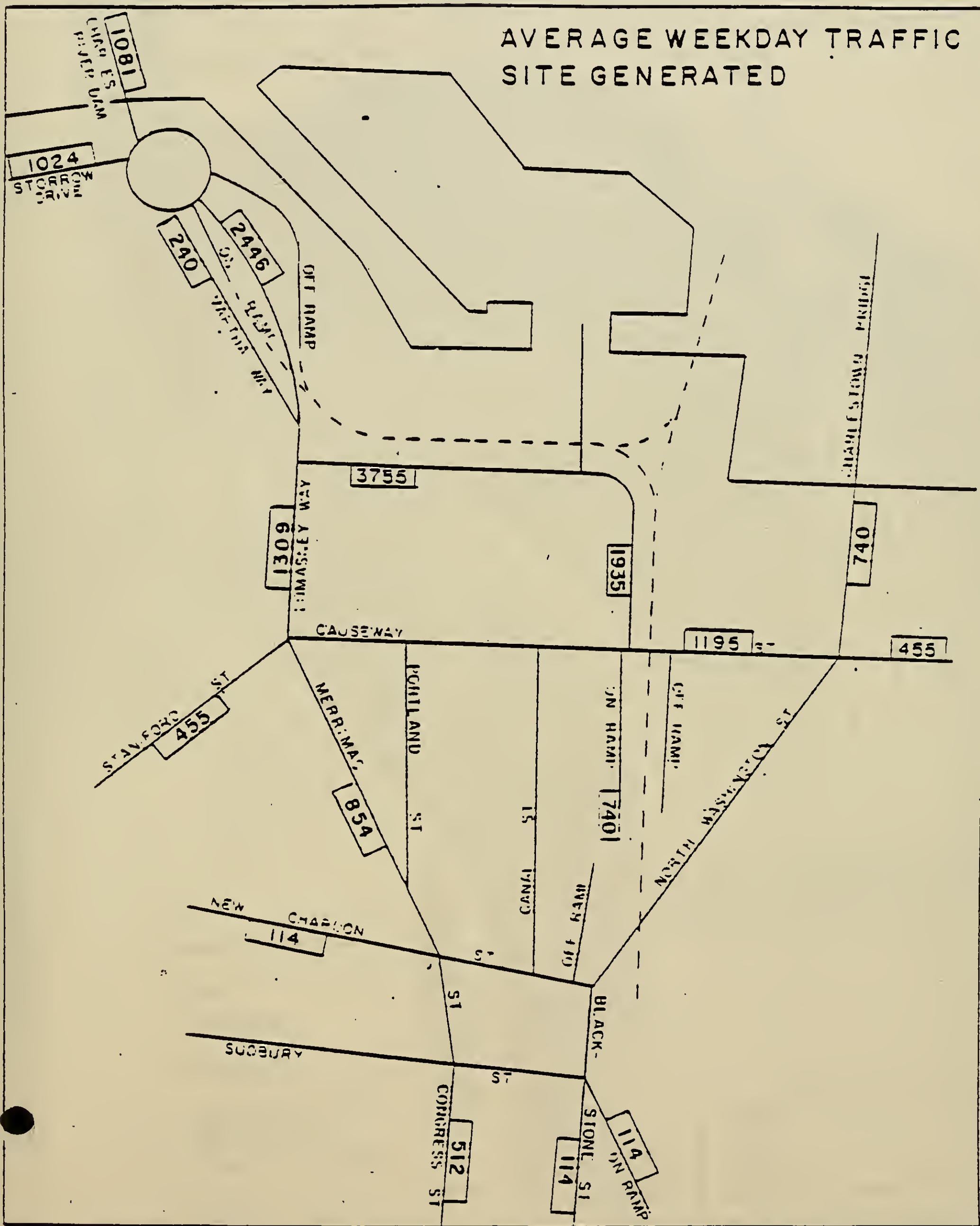
Each intersection was analyzed for the P.M. peak hour for existing (1980) conditions, the 1987 and 2000 no-build base condition, and the Phase I and Phase II (preferred and optional) development in the same corresponding future years.

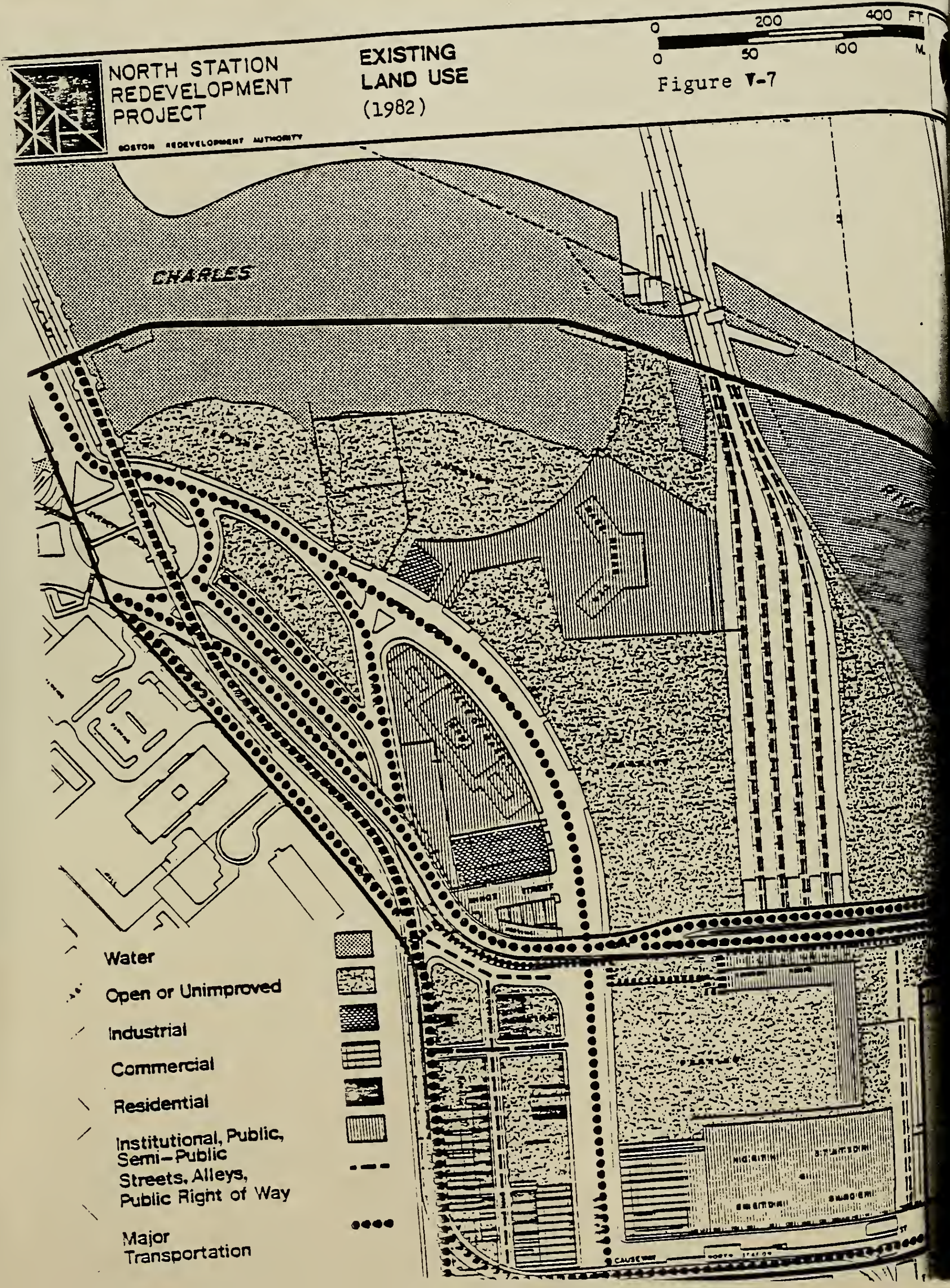
Capacity analysis must assume a certain "Level-of-Service" which is related to the speed at which the traffic may flow, the number of stops, the occurrence of delays, etc. Lower volumes of traffic yield higher levels-of-service, so capacity must be defined at a

FIGURE VI.C-3(b)

TRAFFIC ASSIGNMENTS NORTH STATION

PHASE II 2000 PREFERRED PROGRAM





NORTH STATION
REDEVELOPMENT
PROJECT
BOSTON REDEVELOPMENT AUTHORITY
EXISTING
LAND USE
(1982)
0 200 400 FT.
0 50 100 M.
Figure V-7
CHARLES
Water
Open or Unimproved
Industrial
Commercial
Residential
Institutional, Public, Semi-Public
Streets, Alleys, Public Right of Way
Major Transportation